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AVERAGING OF THE EQUATIONS OF THE STANDARD COSMOLOGICAL MODEL OVER RAPID OSCILLATIONS: INFLUENCE OF THE COSMOLOGICAL TERM ON THE MEAN VALUE OF THE EFFECTIVE BAROTROPIC COEFFICIENT

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With the help of an applied software package written by the authors, we have averaged the effective total barotropic coefficient $\kappa = (-\lambda + p)/(\lambda + \varepsilon)$ of the classical scalar field and the cosmological term and have shown that during cosmological evolution for sufficiently large values of the cosmological constant the Universe transitions from the inflationary stage to a nonrelativistic stage, and then, after a plateau, it transitions to a later inflationary stage.

Keywords: standard cosmological model, averaging of invariant characteristics, mean value of the cosmological acceleration, stage of cosmological expansion, numerical gravitation.

INTRODUCTION

In previous works [1, 2] it was shown with the help of averaging of rapidly oscillating numerical solutions of the equations of cosmological evolution over a macroscopic time interval for the standard cosmological model with zero cosmological term that over the course of cosmological time the contribution to the energy density from microscopic quadratic oscillations of the scalar field begins to dominate over the contribution from the averaged macroscopic scalar field, and that the ratio of these two contributions reaches values on the order of 10^4 at later times. Simultaneously with this, the effective macroscopic equation of state tends to its nonrelativistic limit, i.e., the mean value of the barotropic coefficient $\kappa = p/\varepsilon$ tends to zero. This phenomenon was interpreted in [1, 2] as a process of production of nonrelativistic scalar bosons. In the case of a nonzero value of the cosmological constant λ the invariant cosmological acceleration Ω is determined not only by the barotropic coefficient

$$\Omega = -\frac{1}{2}(1+3\kappa), \tag{1}$$

but also depends on the magnitude of the cosmological constant. Taking the cosmological constant into account, the total barotropic coefficient should be redefined for the classical scalar field $\Phi(\tau)$ as follows[1]:

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[1] The Planck system of units is used: $G = c = \hbar = 1$, and for the time variable, the dimensionless variable $\tau = mt$ is used, where m is the mass of the scalar field (for details, see [1]).

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